

# St. Louis Encephalitis Sequelae and Accidents

GORDON J. AZAR, M.D., and ALFRED H. LAWTON, M.D., Ph.D.

IN THE SPRING of 1964, we participated in a followup study on the survivors of three outbreaks of St. Louis encephalitis (SLE) virus infections that had occurred in the Tampa Bay area of Florida in 1959, 1961, and 1962 (1, 2). This participation afforded the opportunity for a study of accidents in general as well as an investigation of the possible contribution of the SLE infection toward accident causation, since the sequelae reported from St. Louis encephalitis (3-5) may be etiologically related to accidents.

## Method

Separate reports (1, 2) describe the formulation of the study, participants and methods of recruiting them, criteria set up to match controls to participants, and methods used in conducting the study.

A total of 224 persons volunteered for the investigation: 96 were SLE survivors from the outbreaks of 1959, 1961, and 1962; 128 were volunteers for comparison. Each person received a battery of examinations including the Cornell medical index health questionnaire and sensorimotor tests. In addition, each person was questioned in detail about any accidents he had had during the previous 2 weeks or during the previous 12 months, excepting these 2 weeks.

---

*Dr. Azar, who is now a Georgia Heart Association Fellow in Cardiology at Grady Memorial Hospital, Atlanta, at the time of the study was the medical officer of the Human Development Study Center, St. Petersburg, Fla. Dr. Lawton is the director. The center, a field station of the National Institute of Child Health and Human Development, Public Health Service, was formerly the Study Group on Accidents and Aging, Division of Accident Prevention, of the Service.*

If a mishap was reported that had resulted in personal injury or property damage, it was considered to be an accident, and an accidental injury form of the Division of Accident Prevention, Public Health Service, (PHS-T98 and BB No. 68-6226) was completed.

Each accident victim was matched by age, sex, race, and SLE infection with a person who reported no accidents. The test results of the two groups were then compared. In addition, comparisons were made among the subgroups of SLE survivors with and without accidents and controls with and without accidents.

## Test Procedures

The Cornell medical index is a standardized, self-administered health questionnaire which is widely used (6). It consists of 195 questions that correspond closely to those usually asked during a medical interview, including many on the psychological aspects of illness.

The T/O Vision Testor (Titmus Optical Co., Inc., Petersburg, Va.) was used for the visual examinations. Because of time limitations, only the far-vision and the color-discrimination tests were administered. Binocular and monocular vision was tested with and without glasses.

The tests of balance and equilibrium consisted of observations of the screenee's gait, his line-walking and turning abilities, his facility or difficulty in stepping up and down from a stool 8½ inches high, and his stooping ability in picking up an object from the floor; determinations of the maximum distance the person could or would widen his stance base and lengthen his stride base; and the administration of a Romberg test and a quantitative past-pointing test (test of ability to touch a given object correctly with the extended arm and finger, with eyes open and closed).

## Results

The 224 persons who participated in the study reported 41 accidents. Among the 96 survivors of St. Louis encephalitis, 20 (20.8 percent) reported accidents; of the 128 controls, 21 (16.4 percent) reported them. The accidents of the SLE subjects were evenly divided (10 and 10) between those occurring in the previous 2 weeks and those occurring in the previous year, excluding the 2 weeks; the controls reported 3 accidents that occurred within the previous 2 weeks and 18 that occurred within the preceding year, excluding the 2 weeks.

The male-to-female ratio in the accident group was 1:1.9, whereas the ratio in the total population studied was 1:1.4.

Of the 41 accidents, 28 (68.3 percent) were due to falls; 7 (17.1 percent), to motor vehicles; and 6 (14.6 percent), to other causes. The SLE survivors reported all six of the miscellaneous-type accidents.

When the 41 accident victims were compared with 41 persons matched by age, sex, race, and SLE history who reported no accidents, 20 (48.9 percent) of the accident victims and 6 (14.6 percent) of those without accidents had listed 30 or more complaints on the Cornell medical index (table 1). This is a significant difference between the two groups. Statistical significance throughout this paper is based on the minimum contrasts required in fourfold contingency tables to insure a type 1 error of not more than 5 percent—2.5 percent in each tail (6).

**Table 1. Number of complaints listed on Cornell medical index health questionnaire by 41 study participants who had had accidents and paired controls who had had none**

Yes responses (complaints)	Accident group	Nonaccident group
10 or more.....	35	33
20 or more.....	25	19
30 or more.....	20	<sup>1</sup> 6
40 or more.....	13	6
50 or more.....	6	4
60 or more.....	4	3
70 or more.....	1	2

<sup>1</sup> Contrast is significant at the 5 percent level of confidence (6).

The degree of emotional disturbance of each study participant was estimated by an inspection of his answers on the entire form and by the physician's evaluation of these on the basis of suggested criteria. The criteria for a diagnosis of emotional disturbance were 30 or more Yes responses on the entire index, 3 or more Yes responses in sections referring to fatigability and frequency of illness, and 3 or more Yes responses in sections referring to mood and feeling patterns (7, 8). Each person was rated as having none, slight, moderate, or severe emotional disturbances. On this basis, 20 (48.9 percent) of the 41 accident victims, compared with 35 (85.4 percent) of the 41 controls, were rated as having none or only a slight degree of emotional disturbance. Conversely, 21 (51.1 percent) of those reporting accidents, but only 6 (14.6 percent) of those reporting no accidents were rated as having moderate and severe emotional disturbances. The differences are significant.

No statistically significant differences were found between the accident group and the nonaccident group in visual acuity, color discrimination, gait, Romberg test results, line-walking, turning around, stepping up and down, the maximum distance of their lateral base of support, the maximum length of their anteroposterior stride base of support, their picking up of an object, or their past-pointing performances.

Seven sensorimotor tests were selected, and each person was graded from 0 to 7, depending on how many of the tests he performed poorly. The criteria of poor performance were: abnormal gait, a moderate degree or abnormal direction of sway during the Romberg test, inability to walk a straight line without misstepping, difficulty in stepping up or down from a stool, inability to extend the lateral base of support to more than 2½ feet, inability to extend the anteroposterior base of support to more than 1½ feet, and past-pointing with either hand 2 or more inches in either direction.

On this basis, 18 (44 percent) of the accident victims and 17 (42 percent) of the controls had zero ratings; that is, they performed adequately on all of the tests. Three (7.3 percent) of the accident group and 1 (2.4 percent) of the comparison group had ratings of 5 or more, scores which were considered to reflect extremely poor

**Table 2. Performance rating on 7 motor tasks for 41 study participants who had had accidents and paired controls who had had none**

Ratings <sup>1</sup>	Accident group	Nonaccident group
Total.....	41	41
0.....	18	17
1.....	13	12
2.....	3	6
3.....	4	4
4.....	0	1
5.....	1	1
6.....	1	0
7.....	1	0

<sup>1</sup> According to number of tests on which participant's performance was poor: 0—adequate performance on all 7 tests; 7—poor performance on all tests.

performance. The difference, however, is not statistically significant (table 2).

When the subgroups were compared with each other, the results were essentially the same as the above. In none of the comparisons of the subgroups was there a statistically significant difference in sensorimotor performances. The major subgroups differed, however, in the number of complaints and the degree of emotional stability. In the subgroup of SLE survivors with accidents, 14 of 20 (70 percent) were rated as having moderate or severe emotional disturbances, whereas only 1 of 21 (5 percent) of the control subgroup without accidents was similarly rated. For the other two subgroups, the figures were about the same—7 of 21 (33 percent) for the controls with accidents and 5 of 20 (25 percent) of the SLE survivors without accidents.

## Discussion

Although the subjective recall of the SLE victims is questionable because of the time lapse between the original illness and administration of the study questionnaire, they reported that they had had frequent accidents during the acute stages of the disease. They attributed these to sensorial changes and equilibratory difficulties. These impairments and their related accidents, however, have apparently diminished with time and subsequent recuperation. The

most prominent long-term sequelae of SLE found were psychological instabilities (1, 2), and these appear to be related to unexpected mishaps.

When the variables of age, sex, and SLE infection were controlled, no significant differences were found in performances on any or all of the sensorimotor tests between those who reported accidents and the nonaccident controls. The accident victims, however, listed significantly more complaints and gave more evidence of emotional instability than their counterparts in answering the Cornell medical index health questionnaire.

This result raises some questions concerning the reliability of data collected for accident research during investigative interviews. Are complainers more likely to report accidents while noncomplainers tend to ignore or forget them? Since emotional instability and complaining are not mutually exclusive but frequently complementary, psychologically unstable persons are likely to report more accidents than their more emotionally stable counterparts, even when both groups have actually experienced an equal number of mishaps. Some of the statistically determined psychological factors in accident causation may therefore be at least partially attributable to increased reporting by emotionally unstable persons.

Gordon and co-workers (9) also found that the reliability of recall of accident data depends on a number of variables. The more serious the event and the shorter the lapse of time since its occurrence, the more likely it is to be remembered. Accidents at home and at work are recalled more easily than those which happened in public places. In addition, untoward occurrences are more likely to be recalled by adults than by children, by women than by men, and by persons of higher social status than by those of lower social levels. Therefore, in the conduct and interpretation of any accident investigation, these possible biasing factors in data collection must be kept in mind.

The lack of differences in physical disability and in performance between the groups in this study suggests that the actual contribution of these factors to accidents may have been overemphasized and that, statistically speaking,

they play only minor roles as etiological agents. McFarland and Moore (10) have stated that "recent research has indicated that factors of attitude, personality, and adjustment are of greater importance in safe driving than sensory defects, reaction times, and psychomotor skills." Although this statement was made about motor vehicle accidents, there is evidence that it may be applicable to other mishaps as well.

In a National Safety Council study (11), only 1.2 percent of all drivers involved in accidents and only 2.4 percent of drivers involved in fatal accidents had defective hearing or sight, had other medical defects, or were suffering from an illness. In the same investigation, 3.4 percent of the pedestrians involved in all mishaps and 7.7 percent of those involved in fatal accidents had such physical impairments. Among 355 persons admitted to a hospital after suffering accidental trauma, Tannenbaum could find concomitant disease to be a causally related agent in only 8.2 percent (12).

The purpose of citing these studies is not to imply that disease processes and physical impairments are unimportant in accident causation but to emphasize that their readily apparent contribution may be small. Their actual role may be obscured by the highly efficient compensatory mechanism of the human body and by the vast overlay of psychosocial forces. The detection of physical agents in accident causation may require studies of numerous subjects or the use of extremely sensitive instruments and test procedures on smaller population groups. New research design and methodology will need to be considered in future epidemiologic and etiological investigations concerning physiological or pathological processes thought to be related to accident causation.

Finally, psychosocial factors have been found to play a paramount role in accidents. Investigations of these agents need to be expanded with particular emphasis on the applicability of possible remedial measures.

#### Summary

During a followup study of the sequelae of St. Louis encephalitis (SLE) virus infections, accidents in general as well as the possible contribution of SLE toward accident causation were investigated.

The 96 SLE survivors studied reported having frequent accidents during the acute and immediate convalescent stages of the disease. They attributed these accidents to sensorial changes and equilibratory difficulties. Psychological disturbances, however, were found to be the long-term sequelae most closely associated with reported accidents.

As measured by participants' responses to the Cornell medical index health questionnaire, complaining and emotional instability were more prevalent among 41 participants reporting accidents than among 41 reporting none when age, sex, and SLE infection were the controlled variables. No significant differences were found between the accident and the nonaccident groups in performance of seven sensorimotor tests.

Because of possible bias in present methods of collecting accident data and in testing procedures, new experimental design and methodology will need to be considered in future investigations of accident causation and prevention. Particular attention should be given to studies of psychosocial forces as etiological agents and of the possible preventive measures that could be used to stay detrimental psychosocial forces before they can contribute to an accident.

#### REFERENCES

- (1) Azar, G. J., Bond, J. O., Chappell, G. L., and Lawton, A. H.: Follow-up studies of St. Louis encephalitis in Florida: Health questionnaire findings. *Ann Intern Med* 63: 212-220, August 1965.
- (2) Azar, G. J., Bond, J. O., Chappell, G. L., and Lawton, A. H.: Follow-up studies of St. Louis encephalitis in Florida: Sensorimotor findings. *Amer J Public Health*. In press.
- (3) Bredeck, J. F., Broun, G. O., Hempelmann, T. C., McFadden, J. F., and Spector, H. I.: Follow-up studies of the 1933 St. Louis epidemic of encephalitis. *JAMA* 111: 15-17, July 1938.
- (4) Finley, K. H., et al.: Western equine and St. Louis encephalitis: Preliminary report of a clinical follow-up study in California. *Neurology* 5: 223-235 (1955).
- (5) Herzon, H., Shelton, J. T., and Bruyn, H. B.: Sequelae of western equine and other arthropod-borne encephalitides. *Neurology* 7: 535-548 (1957).
- (6) Mainland, D.: Elementary medical statistics.

- Ed. 2. W. B. Saunders Co., Philadelphia and London, 1963, pp. 364-367.
- (7) Brodman, K., Erdmann, A. J., Jr., and Wolff, H. G.: Manual: Cornell medical index health questionnaire. Cornell University Medical College, New York, 1956.
- (8) Brodman, K., et al.: Cornell medical index—health questionnaire III. Evaluation of emotional disturbances. *J Clin Psychol* 8: 119-124, April 1952.
- (9) Gordon, J. E., Gulati, P. V., and Wyan, J. B.: Reliability of recall data in traumatic accidents. *Arch Environ Health* 4: 575-578, June 1962.
- (10) McFarland, R. A., and Moore, R. C.: Human factors in highway safety: A review and evaluation. *New Eng J Med* 256: 792-799, Apr. 25, 1957; 837-845, May 2, 1957; 890-897, May 9, 1957.
- (11) National Safety Council: Accidents facts 1959. Chicago, Ill., 1960.
- (12) Tannenbaum, C. S.: Relation of concomitant disease to the occurrence and management of trauma. *Amer J Surg* 95: 897, June 1958.

## Purification of Shellfish

Oysters and clams can rid themselves in 12 to 24 hours of poliovirus and bacteria when transplanted from polluted water into clean sea water. This finding suggests that shellfish may be purified before marketing, just as milk is made safer by pasteurization. A team of researchers at the Public Health Service Gulf Coast Shellfish Sanitation Research Center, Dauphin Island, Ala., used nonvirulent Type I poliovirus with *Escherichia coli* indicator bacteria. The shellfish had previously been contaminated by exposure in tanks of water containing a constant level of the virus and the indicator bacteria.

Special flow-through tanks were used to determine how rapidly shellfish accumulate disease organisms in surrounding polluted water and how they are able to purge themselves in ultraviolet-irradiated sea water. After 3 hours' exposure in the contaminated water, all oyster samples collected had a virus level at least 10 times that of surrounding sea water.

The team then placed the same oysters in

flow-through tanks in which the water was kept free of virus and *E. coli* by treatment with ultraviolet light. Within the first 24 hours, the oysters rapidly eliminated the poliovirus and the *E. coli* bacteria that had accumulated.

Researchers at the Public Health Service's Northeast Shellfish Sanitation Research Center, Narragansett, R.I., have recently obtained similar results with the Northern hard clam (quahog).

The public health significance of these findings are twofold. The demonstration of the concentration of virus particles by oysters exposed to sea water of low virus content reinforces the concept that they can serve as a potential vector of virus infection. The ability of the Gulf Coast oyster to rapidly reduce its load of poliovirus particles under proper conditions indicates that the prevention of hepatitis transmitted by shellfish is not impossible.